SCENT AND THE WEATHER.

CONTENTS.

SCENT AND THE WEATHER.

"'Oh, that weary scent!' exclaimed Mr. Jorrocks, 'that weary, incomprehensible, uncontrollable phenomenon!' "Constant only in its inconstancy!" as the hable hauthor of the noble science well said. Believe me, my beloved 'earers,' continued Mr. Jorrocks, 'there's nothin' so queer as scent, 'cept a woman!'."

"John Jorrocks.'

Introductory

The above extract from Surtees' well-known writings gives more or less what a good many Masters of Hounds in the old days thought about scent, if they thought about it at all!

Very few attempts have been made to study the problem of scent in a scientific manner, and Masters of Hounds have never paid much attention to words of wisdom on the subject, not because those words fell on deaf ears, but because such advice was of too technical a nature and of little practical use.

Hitherto, Masters of Hounds have had to rely mainly on popular omens and their own experience of hunting. "Hounds rolling at the meet", "the drip on the branches", a "black frost" were supposed to be sure signs of poor scenting conditions. On the other hand, a ground-mist, "hedges standing out black against the landscape" and "a southerly wind with a cloudy sky" were regarded as favourable omens for good scenting conditions. But, no matter how many of these popular sayings were used, exceptions to "the rules" were always occurring. Moreover, there has always been a wide divergence of opinion among Masters of Hounds regarding the actual effects on scent of temperature, humidity, wind, etc. In fact, most Masters came inevitably to the conclusion that "one can never tell".

The above remarks apply particularly to the state of affairs at home, where the weather is more frequently unsettled than it is in this country. In N. W. India the behaviour of the weather is more regular and undoubtedly some useful practical knowledge could be gained from a study of the effect of meteorological conditions upon scent.

It was this idea which led the Master of the Peshawar Vale Hunt, at the beginning of the hunting season of 1932-33, to ask the writer whether it would be possible to give him some indication a day or two ahead of probable scenting conditions. In dealing with this problem it was realised that, apart from meteorological conditions, there were other factors to be taken into account.

plenty of vapour but at the same time there might be a steep lapse-rate* which would promote turbulence†. This would tend to dissipate the vapour and it might not persist long enough for hounds to get it. Thus, in such circumstances, condition (1) would be fulfilled but condition (2) would not be fulfilled.

On the other hand, a pronounced inversion* near the ground would enable the scent vapour, if any, to persist. But if this were associated, as is often the case, with low surface temperature, the actual evaporation of oil might be poor. In this case condition (1) would not be fulfilled, while condition (2) would be fulfilled.

**Lapse-rate of temperature.*

This is also referred to as "the vertical temperature gradient" and signifies the change of temperature with unit height. For example, the average conditions in the lower atmosphere are specified by a positive lapse-rate of 3°F for every 1,000 ft., that is, the temperature decreases by 3° F for every 1,000 ft., above ground-level. When the lapse-rate is negative, the temperature increases with height. This is called an "inversion."

The lapse-rate of temperature is of fundamental importance in determining whether the atmosphere is stable or unstable. (See footnote on "Stability" on page 9.)

†*Turbulence.*

This phenomenon may be roughly divided into two kinds:—

(*a*) Mechanical turbulence, usually referred to as "gustiness," caused by the roughness of the earth's surface, or contours and obstacles of any kind, and also when adjacent streams of air flow past or over each other.

(*b*) Thermal turbulence, due to the difference in density of adjacent masses of air, resulting for the most part from differences in temperature.

"Turbulent" may be used as the general name for the state of any portion of the atmosphere which is disturbed by eddies—both mechanical and thermal effects operating together. The motion of air in which eddies are not being formed is called "stream-line" motion as distinct from the turbulent motion with which eddies are associated. Familiar examples of eddy-motion are the whirls seen in the smoke from a chimney or the "shimmering" near the ground on a hot clear day.

Laws of Evaporation.

Scent is a gas, and it, therefore, obeys certain laws. For practical purposes it is sufficient to give here the generally accepted "laws" of evaporation in so far as they apply to the evolution of scent:—

(a) Evaporation increases rapidly with the temperature of the liquid and decreases with the concentration of vapour in the air moving above the liquid.

(b) The rate of evaporation is proportional to the square-root of the wind velocity, which means that a large increase in the wind velocity only causes a relatively small increase in the rate of evaporation.

(c) Evaporation is proportional to the linear dimensions of the surface of the liquid.

(d) The rate of evaporation increases with contamination, and liquids absorbed in soil evaporate more quickly than a free liquid surface.

Method of Investigation.

It will be realised from the above that many different meteorological factors are involved in a study of the problem of scent, all of which must be taken into consideration and not one by itself. There is little doubt that the reason why hunting people hold opposing views as to what kind of weather heralds good or bad scenting conditions is because they base their opinion on one or two factors only and fail to realise the effect of other factors as well.

The first step in the investigation at Peshawar was to extract from the Hunt records the dates and times when scent was outstandingly good or outstandingly bad for every hunting season from 1923 to 1934. Occasions when scent was variable or "catchy" were ignored. The various meteorological elements for each date were then studied in detail.

For the years 1923/25 only observations at 8 a. m. local time were available, but for 1926/33 observations at 10 a. m. local time were also available together with continuous daily records of wind, temperature, humidity, rainfall, and pressure. Observations of upper air temperatures made by the R. A. F. and detailed notes regarding general weather conditions were also obtainable from the daily weather diary which has been kept since 1925.

The final step in the investigation was an actual comparison for each hunting day in 1932-1935 of meteorological conditions and scenting conditions. This provided a practical test of the correctness of the initial deductions.

Before proceeding, the writer wishes to emphasise the fact that the meteorological data available at Peshawar consist only of the usual observations required for forecasting purposes. For example, the temperature and humidity readings are obtained from standard instruments installed at a height of four feet above the ground in a Stevenson Screen situated in an open space. Actually, in a problem of this kind, it is the meteorological conditions within the air layers near the ground that should be studied. Fortunately, as the result of detailed investigation into agricultural and other problems, a considerable number of publications are now available embodying research which has been carried out on the variation of the meteorological elements within a small distance from the ground. Reference has been made to some of these publications in the following pages.

It should also be noted that the observational data which have been used for the preparation of the tables were obtained in the meteorological enclosure at the Peshawar forecasting centre and not at the actual scene of the hunts, except with regard to the state of the ground. Nevertheless, these data may be regarded as representing to a sufficient degree of accuracy the general conditions in the district.

General Scenting Conditions.

The Peshawar Vale is a horse-shoe shaped plain of alluvial deposits of silt and gravel, partly cultivated and partly barren, and intersected by many rivers, streams and nullahs. Coverts consist chiefly of sugar-cane, fruit-gardens and reed-beds. As already stated, the meets invariably take place in the mornings, from the end of October until the middle of March, although, from the meteorological point of view, good scenting conditions would frequently be obtainable during this period in the evenings as well.

In the following pages, an examination is made of the relation between scenting conditions and the various meteorological elements on 200 days.

In order to make the comparison simpler only days when scent was continuously good or continuously bad for an appreciable period have been used and only conditions in the "open" have been taken into consideration. The observations made at the

Peshawar Meteorological Office would not be comparable with the conditions in covert.

TABLE I.

Year.	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	Total.
Number of good scenting days.	3	3	4	7	14	14	11	12	10	13	8	5	104
Number of bad scenting days.	1	2	6	9	11	12	13	8	9	14	6	5	96

Note 1. Complete records for 1923/6 were not available, hence the small number of days selected in these years.

Note 2 For 1934 only days up to the end of the 1933/4 season have been selected.

Table I is taken entirely from the Hunt records and shows the distribution of good and bad scenting days throughout the period 1923-1934. The conclusion to be drawn from this table is that good and bad scenting days are, on the average, about equally divided during the hunting season at Peshawar.

It must be remembered, however, that until recently no steps have been taken by Masters to avail themselves of meteorological information. As the result of this investigation, and provided the Master takes advantage of the information now available, it is possible that future Hunt records may contain a larger proportion of good scenting days. In fact, the present Master informs the writer that for the current season this is actually the case.

Future Masters may be able equally to improve their average sport by taking advantage of meteorological conditions favourable to scent.

Temperature.

Table II gives a comparison between air temperature (observed at 4 feet above ground) and scenting conditions.

TABLE II.

Temperature in °F	31/35	36/40	41/45	46/50	51/55	56/60	61/65	66/70	71 or more.
Percentage of good scenting days.	20	39	53	68	67	60	43	20	17
Percentage of poor scenting days.	80	61	47	32	33	40	57	80	83

For the years 1923/5 only readings at 8 a. m. (local time) were available and the comparison for these years was, therefore, made with scenting conditions at 8 a. m. (local time) only. For the remaining years the mean temperature was calculated for the period, varying from 30 minutes to two hours, during which scent was very good or very poor.

It will be seen that with low air temperatures, *i.e.*, less than 40° F, scent was generally poor and similarly with high air

temperatures, *i.e.*, above 65° F. The explanation would be seen more readily were ground surface temperatures also available. Unfortunately neither temperature readings at the ground, *i. e.*, at the interface between soil and air, nor readings in the ground have been taken at Peshawar. In this connection the footnote below may be read with regard to the relation between ground and air temperatures.*

Since the meets are held in the mornings and in the cold weather, one may confidently conclude with regard to Table II that the reason for poor scenting conditions with low air temperature is that the temperature of the surface would also be low resulting in a poor evolution of scent. The temperature of the scent-oil itself, when deposited by the quarry, would enable a certain amount of vapour to be produced but the oil would soon be cooled to the temperature of the ground. Conversely, with high air temperatures there would be a rapid evolution of scent because of high surface temperature. Since such high temperatures would probably be associated with a steep lapse-rate, there would also be considerable turbulence and, therefore, rapid dissipation of the vapour, thus causing good scenting conditions to be of very short duration. Apart from other factors, it is evident from Table II that the most suitable surface temperatures for a moderate lasting scent in the Peshawar Vale would be those corresponding to air temperatures from about 40° F to about 65° F, that is, under normal weather conditions.

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* *Relation between ground and air temperatures.*

It is known, from the work of Johnson and Davies† that, in England, the surface layer of the ground has, in winter, a diurnal range of temperature roughly equal to the diurnal range of air temperature except in the case of grass-covered soil which has a smaller diurnal range. The conditions in India, however, are very different, even in winter, owing to the greater influence of solar radiation. For example, it has been found ‡ by Ramdas and Katti that in March at Poona the diurnal variation of temperature at the soil surface is more than 100° F whereas at 4 ft. above ground level the diurnal variation of the air temperature is only about 36° F. Geiger § has found that in Europe the change from conditions at the surface to the conditions of the free atmosphere is marked by a transitional layer at 1½ to 2 metres above ground. Ramdas ‖ states that the height of this transitional layer may be higher in India and appears to vary during the day attaining a maximum in the afternoon and coming down towards the ground in the evening.

† Q. J. Met. Soc., Vol. 53, No. 221.

‡ Ind. J. Agric. Sci., Vol. IV, Part 6.

§ Handbuch der Klimatologie, Band I, Teil D.

‖ Current Science, Vol. II, No. 11.

Obviously the lesson to be drawn from the above is that scent is not likely to be both good and lasting in the Peshawar Vale when

(*a*) The air is very cold and the temperature of the ground is lower than or is in the vicinity of freezing point,

(*b*) The temperature of the air is above 65°/70° and the ground is very hot.

The time when these conditions are likely to arise can be predicted a day or two ahead with considerable accuracy. The Master would be well advised not to meet at an early hour on mornings when it is likely to be very cold, nor to arrange to draw after the sun had risen high in the sky on a clear, hot day.

Lapse-rate of Temperature.

The change of temperature with height is due to many factors which cannot be discussed here in detail, but to enable the reader to grasp the significance of this paragraph the following remarks are given on three kinds of lapse-rate.

(1) *Inversion.*

The temperature of the air generally gets lower with increasing height but occasionally the reverse is the case, and when the temperature increases with height, there is said to be an "inversion." An inversion invariably means thermal stability* of the atmosphere and the absence of turbulence, *i.e.*, the creation of eddies is limited because the wind at the ground is light in inversions and the upward motion of eddies is restricted.

**Stability.*

Any system can remain in equilibrium when the forces acting on it balance each other. If the system is disturbed from its equilibrium position and returns, when left to itself, to its original state, it is said to be in *stable* equilibrium. If, when disturbed and left to itself, it stays in the disturbed position, it is said to be in *indifferent* equilibrium ; but if it goes still further from its original state, it is said to be in *unstable* equilibrium. In meteorology we are mainly concerned with the vertical stability of air masses and it is usual to lay down the condition of stability as the possession of a lapse-rate less than the adiabatic. In the lower levels of the atmosphere, the air is most stable as a rule on calm clear nights and early mornings, but most unstable on bright hot afternoons.

(2) *Adiabatic lapse-rate.*

In the lowest part of the atmosphere the adiabatic lapse-rate for dry air is 5·5° F per 1,000 ft. Adiabatic is a word used in the science of thermodynamics to denote changes which may take place in the pressure and density of a substance when no heat can be communicated to it or withdrawn from it. In ordinary life we are accustomed to consider that when the temperature of a body rises, it is because it takes in heat from a fire, the sun, etc., but in the science of thermodynamics it is usual to consider the changes in temperature which occur when a substance is compressed or expanded without any possibility of heat getting to it or away from it. (An illustration of the change of temperature due to compression is the heating of a bicycle pump.) In the atmosphere such a state of things is practically realised in the interior of a mass of air which is rising to a higher position or sinking to a lower one. If the lapse-rate of temperature is less than the adiabatic, *i. e.*, less than 5·5° per 1,000 ft., the atmosphere is stable, eddies cannot rapidly spread upward, and any turbulence which forms at the ground is restricted to a thin layer.

(3) *Superadiabatic lapse-rate.*

If the lapse-rate is equal to or greater than the adiabatic, eddies can readily spread upward. When an eddy detaches itself from its original environment and proceeds to its new position, it carries with it its original content of heat, water-vapour, dust, etc., including any scent.

Fig. 1 gives curves illustrating the three kinds of lapse-rate, and shows the changes that would take place in the lapse-rate of temperature near the ground on a clear calm day in the cold weather.

The arrows indicate the direction of transfer of heat by turbulence. Temperature is measured along the horizontal axis and height along the vertical axis. The adiabatic condition is shown by the line AB whose backward slope gives a decrease of temperature of about $5\frac{1}{2}^{\circ}$ F for each 1,000 ft. In the diagram a ground temperature of 50° F has been used. For any other ground temperature the adiabatic line would be drawn through the corresponding point parallel to AB. The lines ACD, AE, and AFG represent observations taken under varying conditions. If the decrease of temperature with height is that given by ACD,

FIG 1.

SOME SPECIMEN LAPSE-RATES

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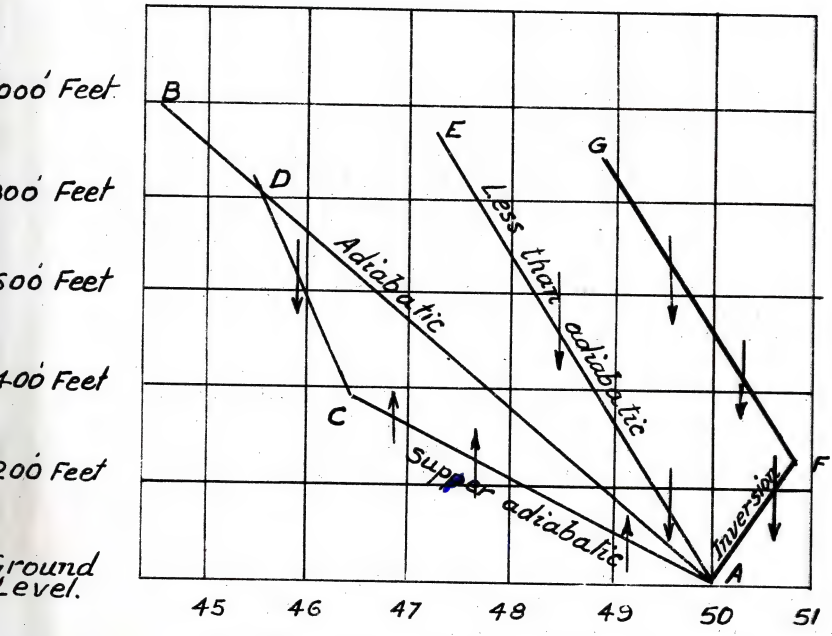

Arrows indicate the directions of transfer of heat by turbulence.

as might be the case towards midday on a clear warm day in the cold weather, the lapse-rate is greater than the adiabatic from the ground up to C, *i.e.*, up to a height of 400 ft. because the angle between AC and the vertical is greater than that between AB and the vertical, the slope of the line being a measure of the lapse-rate. Actually the air will be unstable under the conditions represented by the line ACD up to a height of 800 ft. corresponding to the point D. The line AE makes an angle with the vertical less than the adiabatic line AB and represents a stable condition. The line AFG represents a state of things which frequently occurs at dawn in the cold weather after a clear night. The temperature increases with height up to the height of the point F, and then decreases. The increase of temperature with height, *i.e.*, the inversion, denotes an extremely stable condition.

Table III shows the percentage of good and bad scenting days in Peshawar under different lapse-rates.

TABLE III.

Lapse of temperature in °F per 1,000 ft.	+6 or more.	+5	+4	+3	+2	+1	0	−1	−2	−3	−4	−5	−6 or more.
	Inversion.						less than adiabatic.						Super-adiabatic.
Percentage of good scenting days.	33	67	67	67	71	71	60	60	58	58	53	33	25
Percentage of bad scenting days.	67	33	33	33	29	29	40	40	42	42	47	67	75

It should be noted that the comparison given in this table is based upon lapse-rates which have been calculated from two readings only, that is, the normal air temperature at 4 ft. and the air temperature at 1,000 ft. Actually the lapse-rate within the first few metres should have been used but such data are not available at Peshawar, but with the aid of known facts concerning the vertical temperature gradient near the ground it is possible to draw certain conclusions from Table III.

It will be seen that an inversion or low lapse-rate of temperature is mainly favourable for good scenting conditions. The explanation of the greater number of poor scenting days when there was a large inversion is that such a condition, especially in the early morning, is usually associated with low temperatures and calm wind. However, one may conclude that, apart from other factors, and given an evolution of vapour, scent will last during the existence of an inversion.

The most important conditions for the formation of an inversion are that during the preceding night the sky should be clear and the wind calm. High cloud makes little difference. Other conditions favourable for an inversion are low vapour-pressure in the atmosphere, *i. e.*, low humidity* and low thermal conductivity of the soil. The latter factor is also mentioned under Terrain (*vide* page 19). It is known from the observations obtained at Peshawar that, in fine weather, the inversion, if any, persists until at least two hours after sunrise in December, January and early February, and for approximately one hour after sunrise in November and March. After the "break down" of the inversion the lapse-rate gradually increases and on a clear day it may become very high indeed.

With a lapse-rate somewhat less than the adiabatic, turbulence is small but scent would tend to rise. In such circumstances there would be a "breast high" scent.

With a superadiabatic lapse-rate, that is, a decrease of temperature with height exceeding 5.5°F per 1,000 ft. one may expect scent to be very short-lived owing to its rapid dissipation on account of turbulence. A familiar example of this is the ability of a horseman to smell the fox or the "jack" himself. In such a case, large eddies would be lifting the scent off the ground to a considerable height so that the hounds themselves would smell the vapour very irregularly or perhaps not at all. For this reason a huntsman, on such an occasion, might get the impression that scent was bad, although actually the evolution of vapour might be very good.

The above findings are confirmed by Table III, although it should be borne in mind that the vertical gradient of temperature near the ground may have been considerably greater than that indicated by the two observations at 4 ft. and 1,000 ft. N. K. Johnson † has shown that lapse-rates amounting to several times the adiabatic may exist in the first metre on a warm clear day.

**Humidity.*

When this term is used without any qualifying adjective, it usually refers to the relative humidity. This is the ratio, expressed as a percentage, of the actual amount of water vapour in a given volume of air to the total amount of water-vapour which would be present if this volume of air were saturated under the same conditions of pressure and temperature. Examples of saturated air, that is, air in which the relative humidity is 100 per cent. are fog and cloud.

Absolute humidity may be defined as the actual quantity of water in a unit volume of air. The total possible amount, that is, at saturation, increases with the temperature of the air.

†Geoph. Mem. No. 46 (M. O. London.)

In India even greater lapse-rates may occur than those observed by Johnson. These very large lapse-rates are gradually formed as the sun rises on a clear day when the winds are relatively light. First, the inversion (which exists in the early morning after a clear night) is replaced by a small decrease of temperature with height. Then the lapse-rate near the ground gradually increases until it reaches the adiabatic, and finally, the layer of air at the surface becomes so much hotter than the air above that the lapse-rate between the two is superadiabatic, unless the winds are strong in which case the process may be restricted sufficiently for the lapse-rate to remain comparatively small.

A forecasting centre can generally tell beforehand :—

(1) whether there is likely to be an inversion on the morning of the meet and for approximately how long this inversion may be expected to last,

(2) whether conditions are likely to be favourable for the development of a high lapse-rate, and if so, by approximately what hour the fall of temperature with height will become superadiabatic.

The Master can get this information previous to the meet and arrange his draw accordingly if his hunting conditions render this possible. For example, if, as might happen at Peshawar in March, the information is that an inversion is unlikely to last longer than one hour after sunrise and that a superadiabatic lapse-rate will develop by midday, the Master would be ill-advised to delay at the meet. His best scent will occur during the first hour.

On the other hand, if, as might happen at Peshawar in January, it were foreseen that the temperature would be very low in the early morning, and that the inversion would persist for some time after sunrise and would not be replaced by a superadiabatic lapse-rate until the afternoon (or not at all), then it would be advisable for the Master to delay at the meet and put off drawing his best covert till a later hour, so as to get better scenting conditions by avoiding the early morning low temperature.

Wind Direction.

Table IV giving the comparison between scenting conditions and wind direction shows that this factor apparently has no marked effect, at least in the Peshawar Vale.

TABLE IV.

Wind direction.	Calm.	Variable.	N	NE	E	SE	S	SW	W	NW
Percentage of good scenting days.	53	46	40	43	46	58	63	63	60	33
Percentage of bad scenting days.	47	54	60	57	54	42	37	37	40	67

Southerly winds appear to be more favourable, probably because of their warmer source of origin, than northerly winds, which are generally cold and dry. It is well-known, of course, that scent is usually better if a fox runs upwind. The obvious reason is that the scent is being blown backwards towards the pursuing hounds. Even if the quarry travels downwind, the concentration of vapour reaching a hound's nose would be greater than if the quarry ran across-wind. Presumably a "jack" will not take into account the wind direction only but will shape his course according to the contour of the country, the proximity of coverts and suitable places of refuge.

Wind Force.

The comparison of scenting conditions with wind force in Table V reveals the fact that the chances of scent being good or bad when the wind is calm are approximately equal.

TABLE V.

Wind force on Beaufort scale.	Calm.	1	2	3	4	5	6 or more.
Percentage of good scenting days.	53	57	60	60	37	25	20
Percentage of bad scenting days	47	43	40	40	63	75	80

Note—Force 1=1-3 mph. Force 4=12-16 mph.
Force 2=4-7 mph. Force 5=17-21 mph.
Force 3=8-11 mph. Force 6=22-27 mph.

The explanation is that in a calm the rate of evaporation would be reduced and scent may be localised or "catchy," especially if the surface temperature is low at the time. With moderate winds, however, the rate of evaporation is increased and scent may, therefore, be quite good; but the greater the wind-velocity the more rapidly is the scent carried away. Thus with strong winds the scent no longer persists and Table V shows that with a velocity of force of 6 or more, say, 25 m. p. h. or more, there is little hope of finding a good scent. It is known from experiment that concentration at a constant distance from a source of gas, and "scent" must be regarded as a gas, is an inverse function of wind velocity, *i. e.*, the greater the wind-velocity the less the concentration of scent vapour. Practical experience in Peshawar, therefore, fully bears out John Jorrocks' well-known saying "Take not out your 'ounds on a wery windy day."

The Master should get information regarding the probable strength of the wind, and whether and at what time the velocity may be expected suddenly to increase. Instances have occurred in Peshawar this season when a strong wind sprang up at approximately 10 a. m. and it was quite useless to continue hunting. The probability of such an occurrence had been notified to the Master by the writer and the best coverts had already been drawn and good sport enjoyed before the wind carried away all scent.

Humidity and Cloud.

Table VI gives a comparison between scenting conditions and the relative humidity.* It shows quite definitely that if the air is dry, say less than 30 per cent. saturated, scenting conditions are likely to be poor.

TABLE VI.

Relative Humidity %	0/10	11/20	21/30	31/40	41/50	51/60	61/70	71/80	81/90	91/100
Percentage of good scenting days.	0	0	22	25	61	60	63	69	69	67
Percentage of bad scenting days	100	100	78	75	39	40	37	31	31	33

The physical explanation of this fact is doubtful. One reason may be that dry days are usually associated with pronounced nocturnal cooling and consequently low morning temperature. In the early morning of a cold dry day, therefore, the temperature of the surface of the ground may be too low for a good evolution of scent-vapour.

Another probable reason is that in dry weather the ground may also be very dry, and on clear warm days the surface would "bake up" very rapidly after sunrise. As explained elsewhere, this intense heating of the surface may lead to turbulence and, therefore, to the dissipation of the scent-vapour.

It may also be noted here that the surface temperature of the ground partly depends on the amount of evaporation or condensation of moisture. The effect of evaporation is to lower the temperature of any surface from which it is taking place and the dryer the air the greater the rate of evaporation. Thus, in clear dry weather, although there may be a certain amount of dew or water in the surface layer of the ground in the early morning, this moisture will rapidly evaporate into the air with the rise of temperature after sunrise. Consequently, the cooling effect of this evaporation

*See footnote page 12.

from the surface of the ground would be of short duration unless the ground itself was wet to a considerable depth.

It is a matter of common experience that smells are more pronounced when the air is moist than when it is dry and it may be that the particles of water-vapour act as nuclei on which the particles of scent-vapour may accumulate.

It would also be interesting to know whether animals exude less scent-oil in dry weather than in wet weather.

With high humidity the sky is often cloudy and it will be seen below that on overcast days scenting conditions are more likely to be good than poor.

TABLE VII.

Cloud amount in tenths	0-2	3-4	5-6	7-8	9-10
Percentage of good scenting days.	39	50	55	71	61
Percentage of bad scenting days.	61	50	45	29	39

Table VII shows that scenting conditions are more likely to be good on a dull day than on a clear day, other factors excepted. The reason for this is that the presence of cloud in the sky modifies the flow of radiation. It is well-known that the effect of cloud, particularly of sheets of low cloud, is to shield the earth from the heat of the sun during the day and to diminish the loss of heat from the ground during the night.

With overcast skies all day, the surface of the ground would not be continuously heated and its temperature would rise by a few degrees only.

Hence, although there may not be an early morning inversion (especially after an overcast night), the lapse-rate of temperature near the ground on a dull day, though possibly near the adiabatic, would not increase to the same extent as on a clear day. If, therefore, the surface temperature on an overcast day is high enough to cause an evolution of vapour, the rate of evaporation would be "steady" and good scenting conditions may be expected provided other factors are not unfavourable. On the other hand, if the surface temperatures are very low on the morning of a cold overcast day, scenting conditions may remain rather poor.

With low surface temperatures on the morning of a clear day scent may be poor at dawn but would improve as the sun rose. With high surface temperatures on the morning of a clear

day scenting conditions would probably be good at first but would deteriorate during the day owing to the development of a super adiabatic lapse-rate near the ground.

It may be of interest to note here that low cumuliform clouds, that is "heap" clouds, shaped like a cauliflower or woolpack are normally formed as the result of ascending currents, the lapse-rate below such clouds being equal to or greater than the adiabatic. With such clouds in the sky, the scent-vapour may be lifted too high off the ground.

Information regarding these two meteorological conditions, cloud and humidity, will not be of such immediate value to the Master as that about ground temperature and the lapse-rate of temperature. It may be noted, however, that a forecasting centre can occasionally predict the state of the sky a good time ahead. In such cases it is possible to fix meets so that the best coverts are drawn on the days when there is a prediction of overcast skies. It might even be advisable to change meets to better coverts if such forecasts were made with confidence.

Mist, Rain.

The Peshawar Vale very rarely experiences a fog, but in the cold weather after clear nights when the air is sufficiently moist, it is common for a ground-mist to be formed in the early hours of the morning. This mist is invariably associated with an inversion, *i. e.*, with atmospheric conditions which are stable. As indicated in the paragraph dealing with lapse-rate, an inversion favours the persistence of scent and given a good evolution of vapour, a good scent may be obtained. If, however, the temperature should rise rapidly after the mist has cleared, as is sometimes the case, scenting conditions might deteriorate later.

TABLE VIII.

Rain.	Preceding hunt.	During hunt.
Percentage of good scenting days ...	74	63
Percentage of bad scenting days ...	26 (a)	37 (b)

Note—(a) Ground flooded on 5 per cent. occasions.
(b) Ground flooded on 6 per cent. occasions.

Table VIII shows the effect of rain before and during a hunt. Unless owing to heavy precipitation the ground is flooded, in which case the scent-particles may be completely washed away, rain is evidently a factor in favour of good scenting conditions. The reason is that the scent-oil spreads outwards in water and a much greater area is, therefore, available for volatilisation. Presumably, rain during a hunt would also help to keep the scent "down" by reducing the lapse-rate.

Terrain. (a) State of Ground.

In Table IX the scenting conditions have been compared with the state of the ground under the headings "Very wet," "Moist" (which includes dew*), "Dry" and "Frost."

TABLE IX.

State of ground.	Very Wet.	Moist.	Dry.	Frost.
Percentage of good scenting days ...	57	74	39	36
Percentage of bad scenting days ...	43 (a)	26	61	64

Note—(a) Ground flooded on 29 per cent occasions.

It will be observed that scent is more likely to be good if the soil is moist than if it is dry. The reason for this is that in the former case the scent-oil would tend to spread and thus present a greater surface area for evaporation. Moreover, moist soil has a

Dew, Frost.

About sunset the temperature of the ground begins to fall and hence the air in contact with the ground becomes cooler. Since the capacity of the air for water-vapour decreases with falling temperature, its relative humidity increases. On a clear calm night the air near the ground may be cooled below its saturation point and dew will be formed. This process may be assisted by moisture rising to the surface in damp ground or exuded by plants. If the saturation point is lower than 32° F, the water-vapour condenses as ice in the form of hoar frost.

greater thermal conductivity* than dry soil and on a clear day its surface remains comparatively cool so that there would not be too rapid an evolution of scent. With a dry soil, however, the heat received from the sun remains at the surface which consequently becomes very hot and the evolution of scent may, therefore, be too rapid ; also the lapse-rate of temperature near the ground may become very great thereby causing dissipation of the vapour on account of turbulence.

It should be noted that on mornings when there is dew, the surface temperature may be rather low and, therefore, scenting conditions might be moderate at first, owing to a small evolution of vapour. Since, however, dew is associated with an inversion of temperature near the ground, the scent may be expected to " persist " for some time. Given dew together with a slight wind to assist the evaporation of the scent-oil, a Master could confidently expect good scent. With a frost, although also associated with an inversion of temperature, the surface of the ground may be too cold to produce any appreciable evolution of vapour, but conditions would improve after the frost had melted and the surface temperature had risen.

If the soil has been flooded owing to irrigation or heavy rain and the water is still in the process of draining away, scent might be lost owing to too rapid spreading of the scent oil.

Terrain. (b) Nature of Ground.

In view of the varying nature of the ground in the Peshawar Vale it has not been possible to make a detailed comparison of scenting conditions with the different kinds of terrain. It is

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*_Thermal Conductivity._

The power of the soil to conduct heat is an important factor in the distribution of temperature in the soil as well as in the air above. It varies with different soils and with the water-content of the soil.

Air is a poor conductor of heat and as more and more water replaces the air in the soil, the conductivity of the latter increases. Generally during the day-time a well-conducting soil transmits more heat into the interior, the surface remaining comparatively cool. At night this heat is returned rapidly to the surface to compensate for loss by radiation. Such soils have a smaller diurnal variation of temperature than badly conducting soils. In the latter, the heat gained by day remains mostly at the surface which may become very hot, and at night owing to the radiation loss not being compensated by heat conducted from below, the surface attains a low temperature. Thus badly conducting soils have a large diurnal range of temperature.

known, however, that scent is normally less likely to last over bare ground than over turf or cultivated land.

Considerable research has been carried out on soil temperatures which depend on the amount of solar radiation, and on many other factors, such as colour, cover, thermal conductivity, etc. For example, in connection with the colour factor, recent experiments at Poona * show that a very thin coating of chalk over the black cotton soil depresses the maximum temperature by about 27°F at the surface.

It is an established fact that a surface of vegetation absorbs solar radiation and the effect of grass is to reduce the range of temperature near the ground. Also in the case of grass-land or cultivated soil the oily scent-particles of the quarry would be collected and protected by the leaves and foliage. Hence the evolution of vapour would not be too rapid. In fact, there is no doubt that, on a clear day, although scenting conditions may be good in the early morning over bare ground, they will gradually deteriorate during the forenoon owing to the rapid heating of the surface and consequently the rapid volatilisation of scent oil, whereas over cultivated soil or grass-land the scent-oil would last longer. It is also known that earth is more absorbent for oils than sand, hence the experience of hunting people in the Peshawar Vale that scent lasts longer over plough-land than over sandy soil, particularly as the temperature of a sandy surface becomes very high under the influence of solar radiation.

The above findings also provide a possible explanation of the fact that scent on the salt-covered areas in Peshawar is nearly always poor. A Master with this knowledge would consider lifting his hounds across such an area on to more favourable ground beyond. Again, if the Master found that hounds were running or were about to run over bare ground late in the morning on a hot sunny day, it would probably be waste of valuable time to persist in such a hunt. It would be better to go to a fresh draw where cultivated or grass-lands were more likely to be encountered.

As stated above, one may expect a moderate lasting scent over grass-land if other factors are favourable, but in "covert" the problem is complicated by the sheltering effect of the trees or plants and the fact that transpiration and evaporation from foliage modify the distribution of moisture in the air layers near

*L. A. Ramdas and R. K. Dravid, Current Science, Vol. III, No. 6.

the ground. Kalamkar * has found that the temperature near the soil in sugar-cane (an irrigated crop) may be as much as 25° F less than in the open and that the moisture content of the air inside crops is appreciably higher than in the open.

One must also consider the effect of reduced air-motion inside crops. For example, in a wood the wind force is lessened considerably, to an extent depending on the density of the vegetable growth and number of trees. It will be realised, therefore, that there may often be occasions when scenting conditions may be poor in the open but good in covert. For example, on a hot clear day the scent-oil deposited by a fox or "jack" in the open may be quickly evaporated and dissipated causing poor scenting conditions. On the other hand, if the scent were deposited in covert, it might "last" quite well owing to the reduced effect of insolation †. On a very cold day with light winds, reduced to a calm inside a wood or crops, scent might be poorer in covert than out in the open owing to an insufficient evaporation of scent-oil inside the crops.

If scent in covert is likely to be poor, the Master may wish to allow hounds more time to draw the sugar-cane and reed coverts in Peshawar. Numerous instances have occurred in Peshawar of hounds taking a considerable time to find "jack" on days when scent in covert was poor. A previous knowledge of these conditions by the Master may avoid the annoying occurrence of drawing over "jack."

Another point which a Master would presumably have to consider in connection with the nature of the ground is the effect of contour. As far as the Peshawar Vale is concerned, however, the irregularities in the height of the ground are not likely to cause any appreciable modification of "local" meteorological conditions, except that the nearness of the hills would affect wind strength and direction. On the leeward side of a hill, eddies are formed which might cause the scent-vapour to be widely scattered and dissipated.

Other Investigations.

There are two other publications which have already appeared

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*Current Science, Vol. III, No. 2.

†*Insolation.*

A term applied to the solar radiation, *i. e.*, the sun's radiant energy, received by terrestial objects.

on this subject, namely, "Hunting by Scent" by H. M. Budgett* and "Smoke, Gas and Hunting Scent" by Brigadier A. J. T. Farfan, D. S. O., O. B. E., in the Journal of the Royal Artillery, Vol. LXI, No. 3, October 1934 †. As either or both of these publications may fall into the hands of Masters, it is perhaps advisable to refer to certain points regarding which the writer is not in agreement with the authors of those papers. Brigadier Farfan's article is intended to interest R. A. Officers in some problems of chemical warfare by drawing an analogy to the problem discussed in this paper. From the meteorological point of view, his statements are not entirely accurate and are not supported by any experimental data. His definition of an adiabatic lapse-rate as that in which "the temperature of the air is for all practical purposes the same at all heights" is quite incorrect; but the general remarks of Brigadier Farfan are not subject to any serious criticism.

The book by Mr. Budgett, however, contains assertions with which the writer cannot agree. Nevertheless, it is a most interesting treatise and undoubtedly an earnest attempt to tackle the problem of scenton scientific lines. Although some of his conclusions are in agreement with the findings given in this paper, the writer cannot accept his main theory, namely, that for scenting conditions to be good the ground must always be warmer than the air. Neither does the writer agree with Mr. Budgett's categorical statement that the scientific instrument which he has designed (consisting of two thermometers, one with its bulb in the ground and the other with its bulb about 4 ft. above the ground) will indicate accurately whether scenting conditions are good or bad.

As mentioned on page 3 of this paper, the first condition for a good scent is that there must be evaporation of the oil droplets deposited by the quarry. The rate of evolution of scent will depend on the surface temperature of the ground. The ground may or may not be warmer than the air. If the surface temperature is very low, the evolution of scent vapour may be poor and possibly inadequate. On the other hand, high surface temperatures will promote a good evolution of scent vapour but it may be dissipated too rapidly.

The second condition mentioned on page 3 is that, once there is evaporation of the scent oil, the vapour must "persist" and

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* Published by Eyre and Spottiswoode.

† Published by the R. A. Institution, Woolwich.

it is this point which Mr. Budgett appears to have overlooked. He has evidently failed to realise the effect of meteorological elements on the "life" of the scent. The writer has shown at pages 9 *et seqq.* of this paper that a superadiabatic lapse-rate near the ground (when the surface may be considerably warmer than the air above) causes atmospheric turbulence which, in dissipating the scent, reduces its life, although quite a strong scent may have been formed initially. The writer has also shown that an inversion (when the surface of the ground may be appreciably cooler than the air above*) favours a lasting scent provided, of course, that sufficient vapour has been produced.

The statement quoted by Mr. Budgett from Ganot's Popular Natural Philosophy 1896 that "a chief cause of fog consists in the moist ground being at a higher temperature than the air" is open to serious objection. As a result of meteorological research it is known that fog, *i. e.*, the obscurity of the surface layers of the atmosphere due to suspended particles of condensed moisture, is most frequently caused by the direct cooling of the air below its dew-point.† This cooling may be accomplished either

(a) By the lowering of the temperature of the ground itself, *e. g.*, by radiation at night, or

(b) by the drift of air over a surface which is colder than itself.

In either case an inversion is formed, the surface being at a lower temperature than the air above, a condition contrary to that noted by Mr. Budgett.

Referring to his "scent-indicator," Mr. Budgett states that "the ground thermometer should be pushed into the earth just sufficiently far for the whole of the mercury bulb to be covered by the soil. The air temperature can be taken at any convenient height above the ground, *as it will not be found to vary much up to a distance of six feet.*" The statement, italicized by the writer, is undoubtedly erroneous, for it is a well-known meteorological fact that the vertical gradient of temperature, especially within the first

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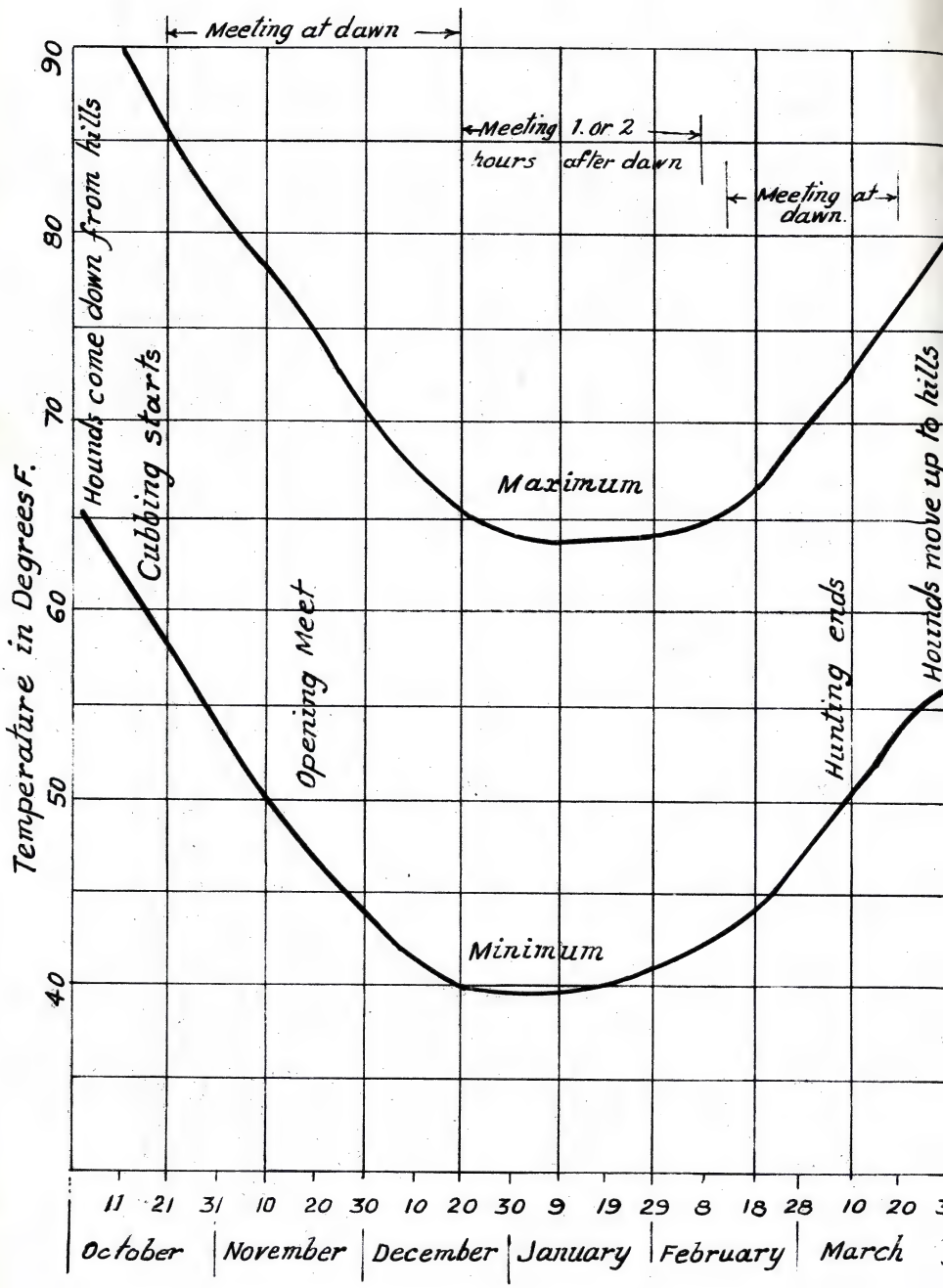
*Ramdas has found that during clear and calm nights at Poona the soil surface temperature may be higher than that of the air above it and that the lowest temperature may be recorded from ½ to 1 or 2 ft. above the surface. The inversion may, therefore, actually start from this level and not from the surface of the ground itself. This requires confirmation. (Ind. J. Agric. Sci. Vol. IV, Part 3.)

†*Dew-point.*

The temperature at which, without change of pressure, the air would become saturated.

NORMALS OF MAXIMUM & MINIMUM TEMPERATURE AT PESHAWAR



It will be seen that October and November are both normally fine-weather months. In fact, from the middle of September until the middle of November there is generally very little rainfall with the result that the surface of the ground is very dry. The air too is very dry* and very little dew occurs until the middle of November; even then it does not last long as the early morning inversions are short-lived. Temperature remains very high throughout October, falls considerably in November and December and rises rapidly again during February and March.

Figure 2 contains two curves showing the normal maximum and minimum temperature for the period October to March in Peshawar. The effect of the temperature on the general hunting programme is indicated on the figure. It will be realised from the foregoing that scenting conditions are not likely to be good in October. Normally there would be a good evolution of scent in the early hours of the morning, but it would be rapidly dissipated soon after sunrise. The same remarks apply to November and early December, but in this period, although the evolution of scent would tend to become less, the life of the scent would tend to be prolonged, lasting perhaps to an hour or so after sunrise.

In some years an early "western disturbance" might produce temporary cloudiness and a little rain in this period, in which case the scenting conditions would improve temporarily. But up to the middle of November scenting conditions are not likely to be good for any length of time and may not improve until the end of the month.

Consequently, in Peshawar it is not advisable to have the opening meet of the season much before November 20th. Other conditions, such as the state of the crops, also indicate this, and a good scenting day before November 20th is an exception.

Towards the end of December there are generally one or two unsettled spells with fairly high morning temperatures, cloudy skies and rain. During these spells scenting conditions may be quite good. On the other hand, the settled periods, normally

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*With regard to the values of humidity given in Table X it should be noted that relative humidity, like temperature, shows a diurnal variation. In fact, the percentage humidity depends as much on the air temperature as on the moisture which the air contains. A curve showing the diurnal variation of relative humidity would, on a clear calm day, be approximately inverse to the temperature curve, the maximum occurring at dawn and the minimum in the afternoon. During the cold weather at Peshawar the humidity may fall to less than 25 per cent in the afternoon of a dry day. The monthly normals of relative humidity at 8 a. m. are, therefore, of little value here since they give no clue to the variations that may occur throughout the day.

The following table summarises average scenting conditions in the Peshawar Vale throughout the hunting season :—

October	... Mainly good scent at dawn but very short-lived. Advisable to meet at day-break.
November	... Good to moderate scent at dawn but of short duration.
December	... Moderate scent at dawn during fine clear spells, improving temporarily during forenoon. Mainly good on dull or rainy days.
January	Poor scent at dawn during fine cold spells, improving to fair in forenoon. Moderate to good scent on dull or rainy days. Advisable to meet at about one hour after day-break.
February	... Moderate to good scent on fine days and very good lasting scent on dull or rainy days.
March	Good scent at dawn on clear days but short-lived towards the end of the month. Mainly good scent on dull or rainy days. Advisable to meet at sunrise.

With this general survey and with his practical knowledge of Peshawar the writer was now in a position to put his experience to practical use, and he so informed the Master.

Every hunting day was usually discussed previously between the writer and the Master, or sometimes one of the Whippers-in would discuss matters. Should any important meteorological event occur indicating a change in normal weather, the writer would immediately inform the Master, usually by telephone, *e.g.*, December 6th, 1934. This procedure continued right through the season with excellent results. as shown below. It is naturally impossible to give all instances where meteorological information was used, but those given are typical.

Illustrative Incidents.

The following examples, written in consultation with the Master, illustrate the combined effect of the various meteorological factors on scenting conditions for particular days in Peshawar during the current season. They show the information given to the Master and how he made use of it.

October 25th, 1934.

(Illustration of a bad scenting day.)

(i) *Predicted information as given to the Master.*

Temperature will be high, rising to over 80° F during the forenoon. There will be an inversion at dawn, but of short

duration, probably not lasting longer than 7-30 a. m. This inversion will be replaced within two hours or so by a superadiabatic lapse-rate near the ground. Wind will be light and the sky clear. Both air and ground will be dry but there may be a slight dew at dawn.

(ii) *The Master's appreciation and plan.*

The meet is at 6-45 a. m. and scent, if any, is not likely to last much later than 8 a. m. It is a cubbing meet and our object is to kill jack, a quick find is essential and it may become too hot for hounds after about 8-30 a. m. No special action on (i) is necessary or possible.

(iii) *Actual scenting conditions.*

The day turned out to be exactly as predicted. The sky was clear all the morning and during the previous night. Winds were light from South. No rain had fallen for weeks and both the ground and air were very dry. The humidity at 9 a. m. was only 25% and dropped to 15 % by 11 a. m. Temperature fell to 56° F during the night, but rose again to 67° F by 9 a. m. and to 82° F by 11 a. m. A moderate inversion existed in the early hours of the morning but was replaced by a superadiabatic lapse of temperature before 9 a.m. It will be seen that the high temperatures, dry air and soil were all unfavourable for the persistence of scent. The inversion preserved its "life" for a short time only. Owing to the presence of additional moisture and reduced radiation in covert scent was better there than in the open.

(iv) *Notes by the Master.*

An attempt was made to run in the open but as soon as hounds came out of covert, they could not run a yard. They were then assisted on to the next patch of cane into which the jack had been viewed, and in covert they could hunt a little. In the end they killed.

It was known that there was practically no chance of scent in the open at all. It would, therefore, have been better for hounds to have restricted them to hunting in covert. It was a mistake from a hunting point of view to attempt to run in the open.

December 6th, 1934.

(Example of good scent lasting for short period.)

(i) *Predicted information as given to the Master.*

Temperature will be about 50° F at dawn and will rise to nearly 70° F by midday. There will be an inversion in the early morning which will probably last until 10 a. m. It is not likely

that a superadiabatic lapse-rate will develop before midday. There will be a good dew, the sky will be partly covered with high cloud and the humidity will be about 50%. The winds will be calm or very light. Scent in the open should be good up to 10-30 a. m.

(ii) *The Master's appreciation and plan.*

The meet is at 7-15 a. m. at Pajaggi. This is the first day this season on which I have been told that scent in the open might be good. It is likely to be good up to 10-30 a. m. and will then deteriorate. My present intention is first to draw left of the road in an area of heavy covert. I am very anxious to find out whether this covert is holding jack or not, and it is very important in view of subsequent meets to discover this. It is also desirable to kill and we are likely to kill in this place. But this draw will take me at least 1½ hours and the jack is not likely to give a run in the open. If I go left of the road, I lose practically all the advantage of any scent there is likely to be in the open. I decide, therefore, to abandon my first draw and to go at once to the second draw.

(iii) *Actual scenting conditions.*

There was a very good dew after a mainly clear night and during the morning the sky became covered with high cloud and the cloud base became lower during the day. The temperature reached a minimum of 46° F just before sunrise, rose to 50°F at 9 a.m. and reached 67° by 11 a.m. The upper air observations revealed an inversion of 2°F up to 1,000 ft. at 10 a.m. which probably persisted for another 30 minutes. Still no rain had fallen but the humidity at 9 a. m. was 55% decreasing to 37% at 11 a. m. There was very little wind. The temperature was sufficiently high to produce a moderate evolution of scent and the heavy dew facilitated this process. The inversion enabled the scent to persist for several hours. The presence of cloud in the sky and a fair amount of water vapour in the air near the ground were also favourable factors. After 11 a m. with the gradual rise of temperature and subsequent break-down of the inversion scent became dissipated too rapidly.

(iv) *Notes by the Master.*

The decision to abandon the first draw was made on the meteorological forecast. This was not luck but deliberate action on my part and is a typical example of the use of meteorological information.

Figure 4 shows the day's hunting as it probably would have taken place without meteorological information. We would have spent 2 hours hunting in covert, killed one jack and then been too late to run other jack in the open.

Figure 5 shows the day as it actually did occur. We had three excellent runs in the open, and it was one of the best days of the season, certainly the best up to date. My object from the beginning was to move rapidly and get on terms with as many jack as possible before scent disappeared. The day as it turned out was quite different from what it would have been without meteorological advice, and, of course, infinitely better.

January 17th, 1935.

(Example of altering a draw.)

(i) *Predicted information as given to the Master.*

Temperature will probably be below freezing point at dawn but will rise to about 55°F by noon. There will be an inversion at dawn lasting for approximately two more hours but a superadiabatic lapse-rate will develop near the ground by about midday. There will be a hard frost at first and a clear sky, but a little high cloud will appear in the sky during the forenoon. Humidity will be about 65% at first but decrease to less than 35% by midday. The wind will be light at dawn but freshen during the morning.

(ii) *The Master's appreciation and plan.*

This prediction was given to me during a cold spell which had been going on for some time, and all meets were an hour or more later than sunrise, *viz.* at 8-30 a. m. The meteorological information obviously predicts a heavy frost, and clearly indicates a poor scent from 8-30 till 10 a. m., owing to poor evolution of scent due to low ground temperature. Scent will improve at 10 a. m., when it will continue good till about noon and then will die off, owing to the development of a superadiabatic lapse-rate.

I have three coverts in the draw, Shakarpura, Kankola and Nahakki. My best covert, Shakarpura, is nearly sure to give me a run, and I had intended to draw it first, *i. e.*, at 9 a. m. Kankola may hold and may give me a run, while Nahakki, my third draw, is a sure find but the jack there are not good runners and not likely to go far. I am most anxious to kill tomorrow for the hounds' sake, as we have not had blood for a week.

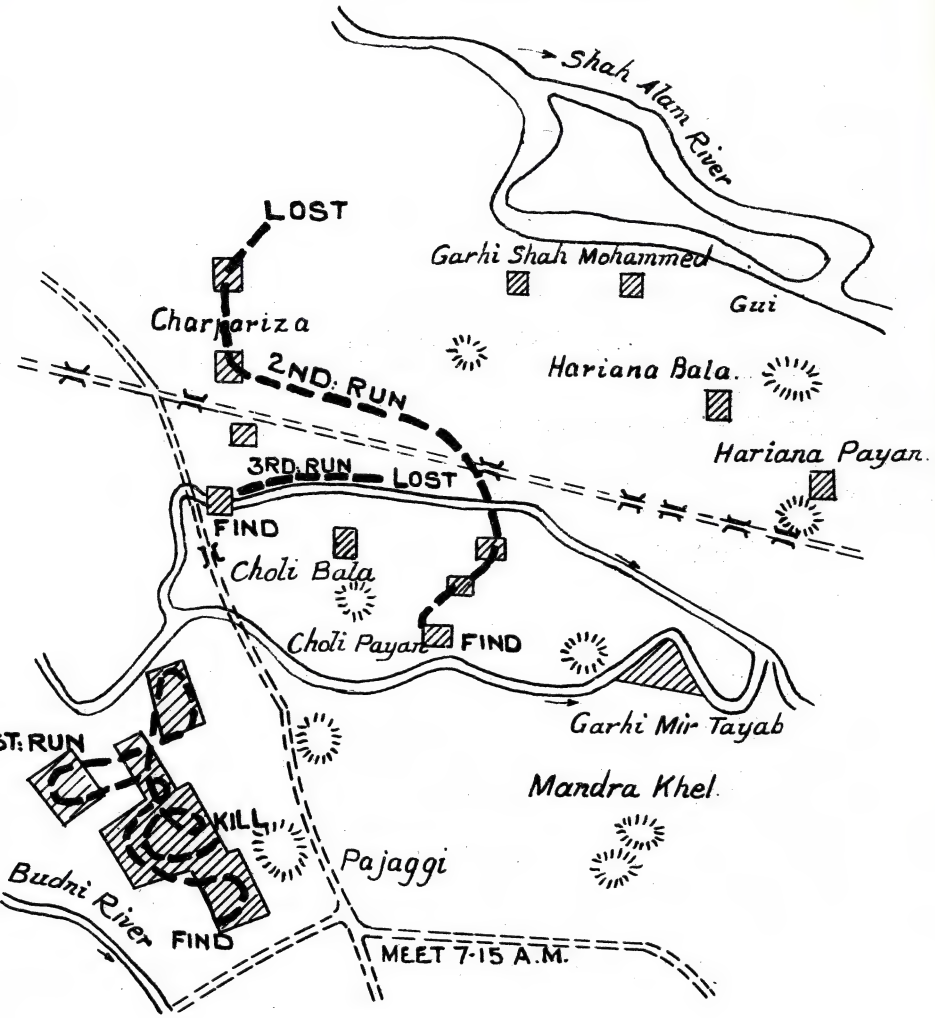
I will, therefore, change my draw with the object of bringing my best covert, Shakarpura, into the period of best scent, *i. e.*, between 10 a. m. and 12 noon. I will waste time by drawing Nahakki first and I will arrange to arrive at Shakarpura at about 10 a. m.

FIG 4

P.V.H. 6.12.1934

As Hounds would have run without meteorological information

Scale Approx: 1" To 1 Mile



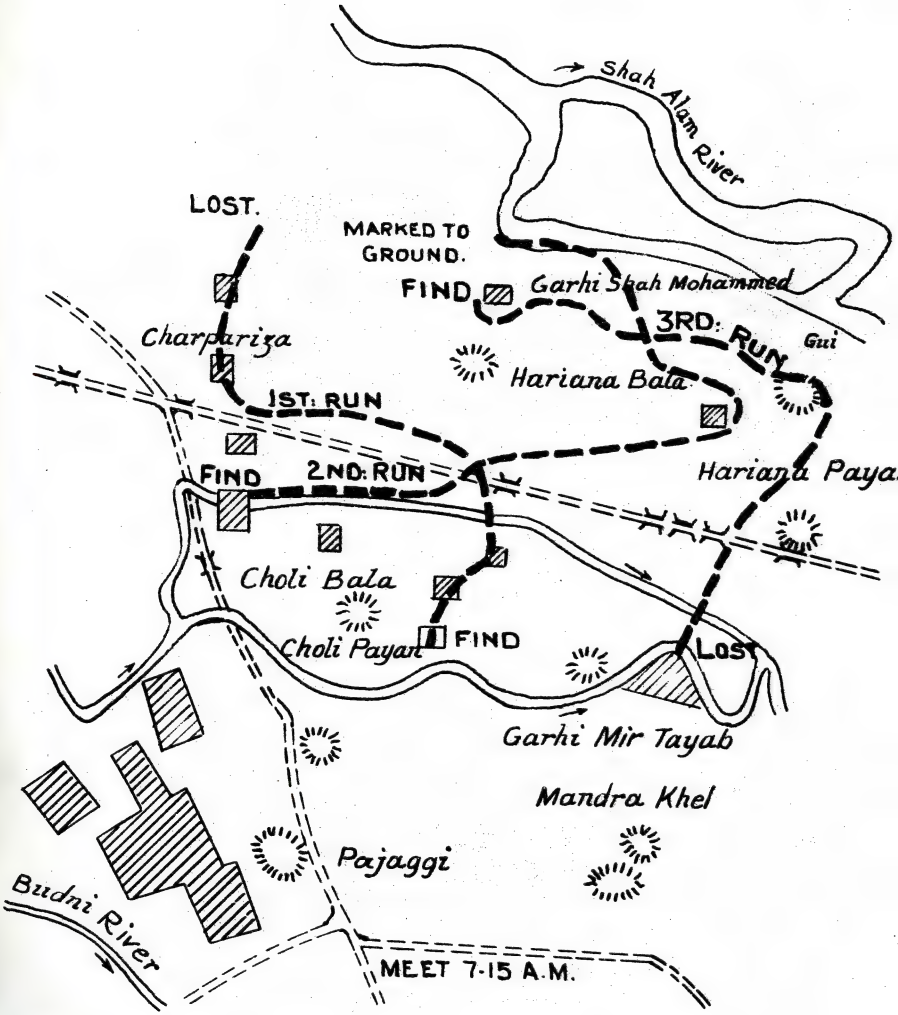
NOTES:-			
	1ST: Run	2 Hours	in Covert.
	2ND: Run	3 Miles	in Open.
	3RD: Run	½ Mile	in Open.

Much valuable time would have been spent in covert when scent was good in the open. & the field would have stood 2 Hours outside covert. Hounds would have run 3½ Miles only in the op

P.V.H. 6.12.1934

As Hounds actually ran, the Master having altered his draw on meteorological information.

Scale Approx 1" to 1 Mile



NOTES:—			
	1ST: Run	in Open	3 Miles
	2ND: Run	in Open	4½ "
	3RD: Run	in Open	4 "
		Total	11½ Miles

Note difference in distance Hounds ran in open, as the result of changing the first draw on meteorological information.

(iii) *Actual scenting conditions.*

There had been rain on the 15th January and the ground was quite moist. Following a clear night there was a hard frost on the morning of the 17th. The grass minimum thermometer recorded a temperature of 21°F and even the air temperature fell to 30° F. At 9 a. m. the air temperature was still very low, *i. e.*, 32° F and the humidity was 74%. By 12-30 p. m., however, the temperature had risen to 52° F and the humidity fallen to 35%. The upper air temperature observations made at 10 a. m. gave identical readings at 4 ft. and 1000 ft. Winds were light all the morning but freshened at midday. The sky was clear at dawn and became partly covered with high cloud by midday.

The reason why scent was poor at first was undoubtedly because of the small evaporation of scent-oil due to very low ground temperature. As the sun rose and the surface of the ground became warmer, the rate of evaporation of the scent-oil was increased. The morning inversion persisted until 10 a. m., and, as one would expect, the scenting conditions were very good at that time. Towards midday, as the air near the ground became considerably warmer, the lapse-rate of temperature approached the adiabatic and scent became "breast-high". Soon after midday, however, the lapse-rate near the ground must have exceeded the adiabatic. Consequently, turbulence set in and scenting conditions, therefore, began to deteriorate in the early afternoon.

(iv) *Notes by the Master.*

It was very cold and we delayed moving off from the meet. Scent was poor up till 10 a. m. and we had several short hunts on short-running jack from Nahakki. We arrived at Shakarpura at 10 a. m. Drawing it then, we had two excellent hunts. The first one was on a much improved scent. The second hunt from the same covert took place at about 11 a. m. and was six miles in the open on a very good scent indeed, ending with a splendid kill in the open.

Thus, the day was a typical example of meteorological information on the day before the hunt being of first class value.

If I had kept Shakarpura as my original first draw, I would have had an "ordinary" day, but by changing it to the best scenting hours we scored a really first class day's hunting.

As Kankola was on the way home, I drew it at 12-45 p. m. but, as predicted, scent was nil. Also, hounds and horses by then had had quite enough.

Questions to ask a Forecasting Centre.

It is not suggested that a forecasting centre should be asked to predict scenting conditions as well as the weather conditions. A Meteorologist is a busy man and cannot normally spare time to give detailed advice to Masters of Hounds. It is to enable the latter to take full advantage of a meteorological service that this pamphlet has been written. The procedure adopted and found suitable at Peshawar has already been described, but other methods are also possible and can be devised to suit local conditions.

The writer suggests that any Master who wishes to apply the information in this paper to his hunting problems should first make out, in consultation with a Meteorological Officer, a seasonal survey such as that for Peshawar on pages 24 to 27. Having studied this the Master should examine in detail, for, say, one complete season, the effect of the various meteorological elements on scenting conditions as given on pages 7 to 21. From this study a sort of catechism can be evolved which will be found to supply in general all the questions to which the Master is likely to want to know the answers.

The following are some specimen questions which, it is suggested, should be put to a forecasting centre. The replies will enable a Master to deduce with fair accuracy how probable meteorological conditions will affect scent, and they will give him a good idea how he can benefit by the information :—

(1) What will be the temperature of the air near the ground at sunrise tomorrow, and how will this temperature change during the day ?

The object of this question is to estimate the probable time at which the evaporation of scent-oil and, therefore, the production of scent-vapour, will be at its best. For example, on a clear day at Peshawar the production of scent is likely to be poor when the air temperature is much below 45°F and too rapid when the air temperature exceeds 65°F.

(2) Will there be an inversion in the early morning ? If so, for approximately how long after sunrise may it be expected to last ? Is it likely that a superadiabatic lapse-rate will develop within the first few feet of the ground during the day ? If so, by approximately what hour ?

The answers to these questions should enable a Master to deduce the period during which scent may be expected to "persist."

(3) What will be the wind force and direction and what changes in the wind may be expected during the day ?

The object of this enquiry is to find out whether the strength of the wind is going to be such as to cause a good evaporation of scent-oil without completely dispersing the vapour at the same time.

(4) Will there be a frost or dew ?

These phenomena have their effect both on the evolution and "life" of the scent-vapour, since they are always associated with low surface temperatures, but generally with an inversion also and, therefore, with stable atmospheric conditions.

(5) What will be the state of the sky ? Will there be any precipitation ?

The answers to these questions will supplement the answers given to questions 1 and 2. For example, although the lapse-rate of temperature near the ground will not become so steep on a dull cloudy day as on a fine, clear day, the surface temperature on an overcast day may possibly remain too low for a good evolution of scent vapour.

Any well-informed forecasting centre would be able to supply answers to the above questions, provided sufficient notice is given. A Master of Hounds who has studied the previous pages and who has worked out a few examples with the aid of a Meteorological Officer will find no difficulty in deciding at once whether the meteorological information is of use to him, and how to use it.

No. 1935/3.

Scent and the Weather

by

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Meteorological Officer, R. A. F.

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No. 1935/3.

Scent and the Weather

by

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Meteorological Officer, R. A. F.

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